LUBRICATION

A Technical Publication Devoted to the Selection and Use of Lubricants

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Lubrication of Heavy Duty Materials Handling Equipment

HANDLING of materials by mechanical methods supplanted man and animal power with the development of the "heavy industries." To iron and steel probably is due the major part of the credit for perfection of the conveyor, for the materials required have to be handled in bulk from the time that ore, fuel and limestone is delivered for charging into the blast furnace until the finished shapes are turned out by the rolling mill.

Today the skip hoist is probably the most spectacular conveying element in the steel mill; it is massive, exposed and obviously a most durable "cable car" affair. As it runs up and down the runway to carry the charge to the top of the furnace it seems to breath in unison with the furnace itself.

Elsewhere in the mill, however, are other materials handling elements of equal durability, if not as spectacular to the layman. The ore-docks of any water-side mill must be fitted with a number of these elements in the form of unloaders and belt conveyors. In turn, within the mill there are the traveling overhead cranes for handling ingots to the soaking pits, for changing rolls in the rolling mills and for moving the finished stock to or from the yard. All told the steel industry possesses a wide variety of conveying or handling equipment.

CRANE MECHANISMS

Hoisting and lifting machinery dates back to antiquity. It was not until the industrial revolution of the 19th Century, however, that we progressed beyond the hand-crane stage. Then followed the steam, hydraulic, electric and gasoline crane. In the beginning the crane was strictly a hoisting mechanism, the economic advantages of lifting a load vertically and then moving it horizontally were soon appreciated, however, to the definite benefit of those industries producing massive materials.

Iron and steel profited immensely from the development of the electric crane. From the ore pile to the shipping department it has paralleled its counterpart, the conveyor, as one of the primary means of moving the products. Visualize the ladle crane for handling molten metals; the ingot stripping crane which removes ingots from their moulds; the ingot charging crane used in connection with the soaking or heating pits; the cranes which charge the open-hearth furnaces; and those which transfer steel shapes or plates from cooling racks to storage and thence to cars, boats or trucks for shipping. In other words, the crane in some form or other has become the keystone unit in the steel industry.

The operating conditions under which the crane must function do not permit of much protection of the moving parts; we are confronted with the vagaries of the weather, the effects of high temperature; an acid condition in the atmosphere along with a high dust content. Variations in temperature reduce the lubricating ability of certain lubricants, acid and moisture are corrosive and dust is abrasive. To counteract these, the petroleum chemist has

developed his research covering lubrication into a major problem. Most recently has he been confronted with markedly increased load conditions and the possibility of film rupture.

The crane designer and the lubricating engineer have cooperated by perfecting their methods of lubrication and protecting their bearings and reduction gears wherever practicable.

Courtesy of The Jeffrey Manufacturing Co.

Fig. 1—A Jeffrey portable stacking boom. This is severe service as the boom idlers are smaller and run faster than the line idlers, yet they handle the same tonnage.

All this has led to lubrication economies through reduction in loss of oil and grease, and protection of finished products against oil-spotting during the process of handling. The effects of oil or grease upon such products, is far reaching. Any lubricant after it gets on a sheet of steel, for example, while the latter is hot, cannot be entirely removed, even in the annealing process. And yet, full finished sheets, or sheets for coating, must be entirely free from grease or oil spots. Pickling thus far has proved unsatisfactory in removing these spots entirely. Sheets to be coated by galvanizing or tinning must be free of scale, and this cleaning is accomplished by pickling. The various acids used will remove scale, but cannot be depended upon to remove grease or oil. Sheet steel should furthermore be free of spots regardless of whether the process within the mill itself would be impeded due to their existence, in view of the fact that the customer may have a desire ultimately to paint the surface.

The safety factor is equally as important as the elimination of oil and grease drippage from overhead equipment and the protection of the product.

How Design Affects Lubrication

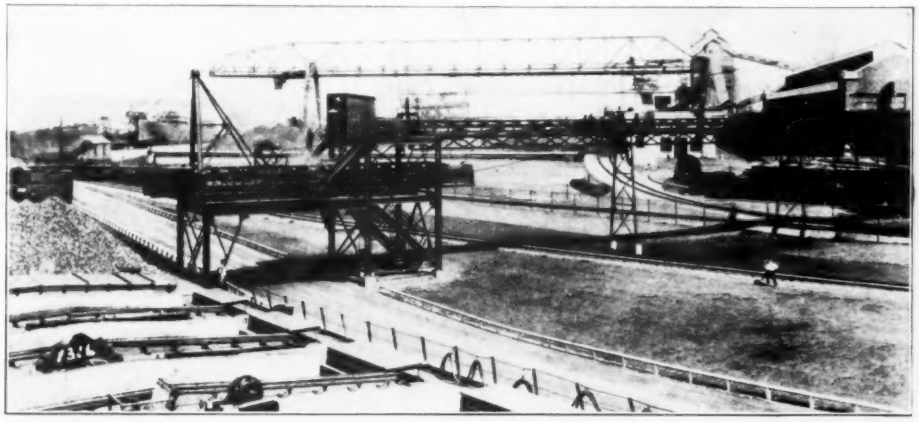
The extent to which dripping of lubricants may occur will, in part, depend upon the design of the equipment. In some of the most modern installations of overhead electric cranes, it has been noticed that dripping still prevails, although not to as great an extent as in older types of machines, due to the fact that equipment manufacturers have given considerable thought to this feature in design and construction. It still remains, therefore, as a potential detriment and in most cases it can be attributed directly to one of three causes, viz.:

1. Excess application of lubricant
2. Use of improper lubricants
3. Carelessness in handling lubricants during the process of application.

In plants which are still operating equipment of the older type, it has been necessary for the management to collaborate with the manufacturers of lubricants and lubricating devices to overcome any deficiencies which may prevail; otherwise they may be unable to meet competitive production.

A variety of methods are available for the lubrication of overhead machinery. Considerable attention is being given to standardization by both equipment manufacturers and lubricating engineers, in cooperation with the operating and maintenance departments in many plants. The primary purpose is to devise ways and means to prevent the loss of lubricants. It is often a distinct problem, by virtue of the wide range in operating temperatures which prevails, and the tendency of certain types of lubricants to creep, and ultimately drip from the lubricated parts. High temperature work has the effect of reducing the viscosity of lubricating oils, or the consistency of greases, oftentimes to render them so fluid as to require the most carefully designed seals or housing devices to enable their retention. For this reason, the trend has been toward heavier oils and harder greases.

Where oil is employed, the primary objective should be to use as little lubricant as possible commensurate with protection of the bearings. Waste, felt, or some other absorbent material can, of course, be used to take up any excess lubricant after it has seen service; saturated waste or felt will have to be removed periodically, however, otherwise it will fail to serve its purpose. It is also possible to install drip pans. Unfortunately, however, these latter will require periodic emptying; they may also interfere with the changing of brasses when this becomes necessary. So neither is as practicable as measured lubrication.



Courtesy of Robins Conveying Belt Company

Fig. 2—Showing a Robins conveyor system for loading coke and in the background an ore and coal bridge. Note the extensive span of these units over the storage areas.

All of the oil and grease damage to sheet steel, however, should not be charged directly to drippage from cranes and their runways, nor to the negligence on the part of the crane oiler or operator. In japanning or enamelling of furniture, or other full finished stocks, a small particle of oil saturated dust, even as minute in size as a pin point, falling onto the sheet after pickling, and before it goes into the annealing box, will expand into a discoloration sometimes as large as a ten-cent piece or a quarter. This is due to expansion of the vapors which results when certain petroleum products are subjected to annealing oven temperatures.

Bearing Lubrication

Crane truck bearings of the railway type, lubricated with oil-saturated waste packing have always been a prevalent cause of oil drippage on to the runway and the supporting structural members. Hoist and sheave bearings in turn may drip onto the stock. The latter may be a detriment to finish as stated above; the former creating a hazard to the personnel. Both are worthy of serious consideration.

Careful study has resulted in the conclusion that the use of waste and oil can be discontinued in favor of grease, using a product of pliable consistency. In many plants such a procedure has led to virtually entire elimination of drippage. In some installations the grease is placed in specially designed pans and held against the journals by means of springs fitted to the underside of the pans. This type of lubrication is enduring and requires attention only when regular inspections are made.

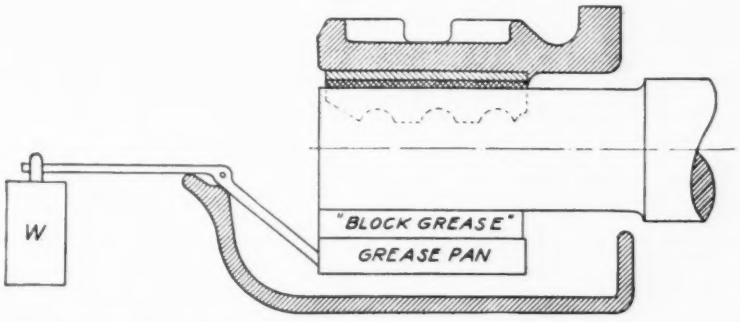
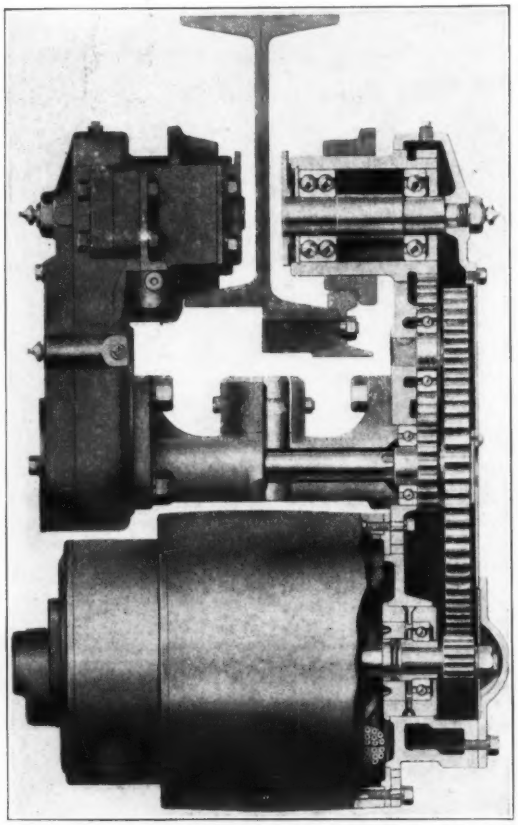


Fig. 3—Showing arrangement for applying block type greases to crane journal bearings to overcome oil drippage.

Grease can also be kept in close contact with the journal by using a weight and lever device, as shown in Fig. 3. In this the grease container is from 2½ to 3 inches wide, the length

being the same as the bearing, in order to insure that the entire surface is in contact with the grease. Pressure can be regulated by adjusting the location of the weight on the end of the lever according to the temperature at which the element is operating.

It is important to remember, however, that should carelessness prevail, even in the handling



Courtesy of Shepard Niles Crane & Hoist Corp.

Fig. 4—Details of the motor driven anti-friction bearing trolley on a Shepard Niles hoist. Note gear assembly and bearings in cut-away section.

of grease while it is being applied to the journal boxes, there is a chance that some of it may drop down later onto the runway and perhaps the product below. This will also apply to the truck bearings of the trolleys.

Selecting the Grease

The operating temperature must always be considered when selecting any such grease. Where cranes are to operate continuously over open hearth furnaces or annealing ovens the grease should have a comparatively high melting point, in order to prevent undue reduction in consistency and obviate the possibility of separation.

Roller Bearing Requirements

Grease lubrication is also practicable on cranes equipped with roller bearings. Normally these latter can be more tightly sealed than the plain or sleeve type bearing. On such elements a medium consistency grease of high melting point, containing an oil which has a viscosity in the neighborhood of 175 seconds Saybolt at 210 degrees Fahr. will serve the purpose effectively. In selecting such a grease the consistency must be such as to enable ready application with a hand operated grease gun. As a general rule, the same type of lubricant can be used on all anti-friction bearings on the average crane. The melting point of such a product should be in the neighborhood of 300 degrees Fahr. or higher; there should be no tendency toward separation, nor should the grease oxidize to gummy residues or separate oil.

Gears and Pinions

These elements must be lubricated according to their design, housing and the means of lubrication available. Where cases are used for enclosure, it has been found that the smaller the amount of lubricant used to meet the conditions, the less trouble is experienced. After the teeth are coated very little gear lubricant is required to keep a film on them. The distance between the gear case and the gear or pinion should not be over ½ inch; ¼ inch would be the minimum, inasmuch as sufficient gear lubricant can be carried in a case with such clearance. Furthermore, when this small clearance is used, the drag on the gear or pinion is kept down to a minimum.

Straight mineral lubricants are best for such service. Their fluidity, however, must be chosen according to the type of housing. A viscosity range in the neighborhood of 500 to 1000 seconds Saybolt Universal at 210 degrees Fahr. according to atmospheric temperatures will normally meet the requirements, where gears and pinions are so housed as to prevent leakage of the lubricant. Should leakage be possible, it will be advisable to give careful study to the matter of raising the viscosity. On the other hand, the gear lubricant must not be too heavy in cold weather, otherwise it may wipe off the cases. This is especially true where the latter are of sheet metal construction.

Frequently in non-oiltight housings it will be best to apply the lubricant by hand, and guard against any undue accumulation of lubricant in the base of the housing, to result in possible leakage. This may require the use of a product oftentimes as high as 5000 seconds Saybolt at 210 degrees Fahr.

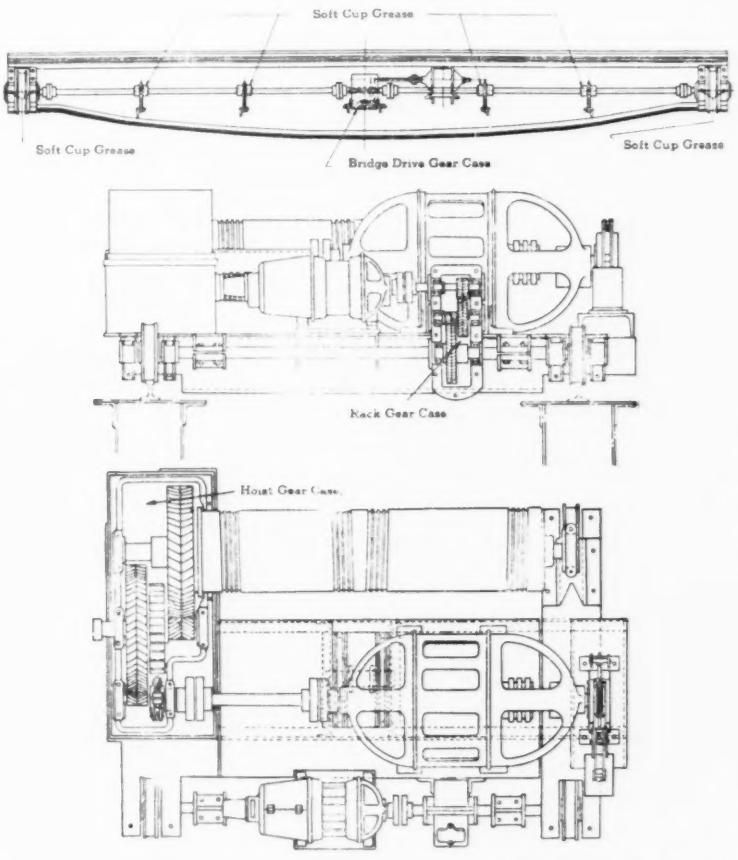
So much for the operating temperatures. When dealing with a lubricant of such high viscosity at lower atmospheric temperatures,

on the other hand, the congealing effect of the latter may lead to a decided increase in power consumption, particularly on starting.

Hoisting Cables

The cables or wire rope with which the crane is equipped also require lubrication. The usual types of wire rope lubricants, however, cannot always be used with positive satisfaction, in view of the wide range of temperatures to which they are exposed, and the fact that they are in direct line with the materials being handled. Obviously any dripping of lubricants from the cables would most assuredly reach these materials. For this reason, best practice is to specify that the cores of the ropes be treated during manufacture with a lubricant of heat-resisting characteristics and free from all fillers.

Where a rope core has been treated with a lubricant of this type, the latter will work its way out from the core, through the strands of the rope, not only to give additional life, but also to prevent premature corrosion and rusting. It is important to remember that as a wire rope is worked back and forth over the sheave wheels, any contained lubricant within the strands may work out to deposit on the wheels, and be subsequently thrown off.



Courtesy of Whiting Corporation

Fig. 5—Details of a Whiting crane showing lubrication recommendations. The use of herringbone gears assures of a pumping action on the oil and flood lubrication of these parts at all times. Frequency of bearing lubrication is based on operating conditions.

Auxiliary Bearings

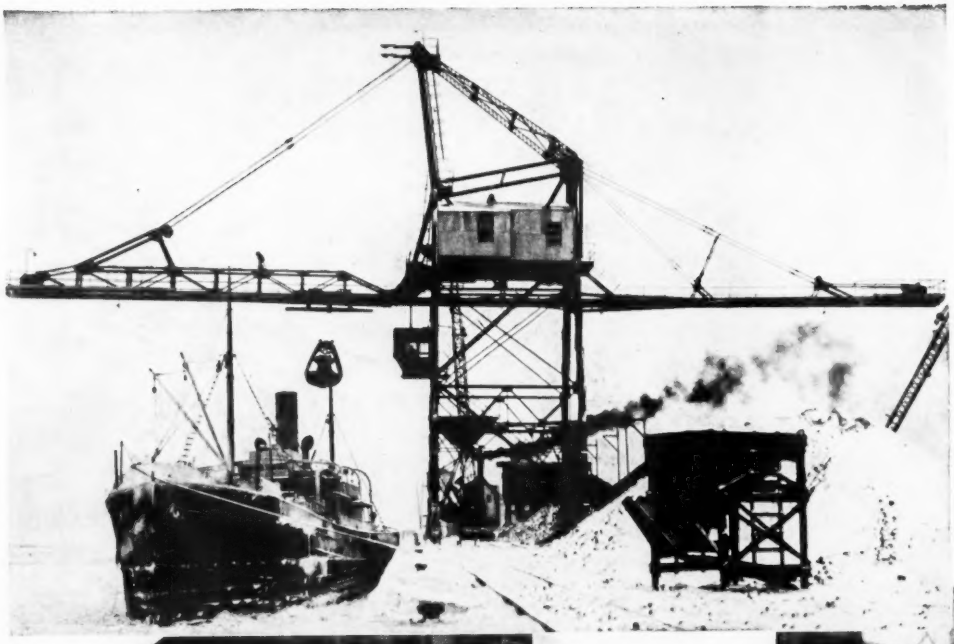
Sheave wheel bearings are usually of the sleeve type. They can be effectively lubricated with grease by means of a hand operated grease gun. The amount of lubricant necessary to meet such requirements is comparatively small and gun applications should be carefully controlled in order not to deliver too much lubricant. Otherwise, it might find its way out to the ends of the bearings to drip and cause trouble.

Other sources of drippage are the back axles and the line shafting. While these are usually equipped with an industrial grease fitting of some type, it is generally the practice of the operator to consider that if a little bit of grease is good, a whole lot will be better; as a consequence, they are often over-lubricated.

Motor bearings may also cause similar trouble. If the cavity for lubricant is filled to excess there is bound to be a drippage and, in the case of the trolley motors, due to their passing back and forth over the product being manufactured, there is likely to be damage to the product. Care should be taken in the selection of the lubricant for these bearings, as well as its application. In most cases dripping is due to the tendency to keep motor bearings clean by flushing out with excess lubricant, and the desire of the workman to prevent hot bearings and avoid criticism. The same holds true in connection with anti-friction bearings using grease, here however, the judicious use of vents will serve as a preventative of over-lubrication.

Centralized Lubrication

The manufacturers of lubricating devices have given considerable thought and time to

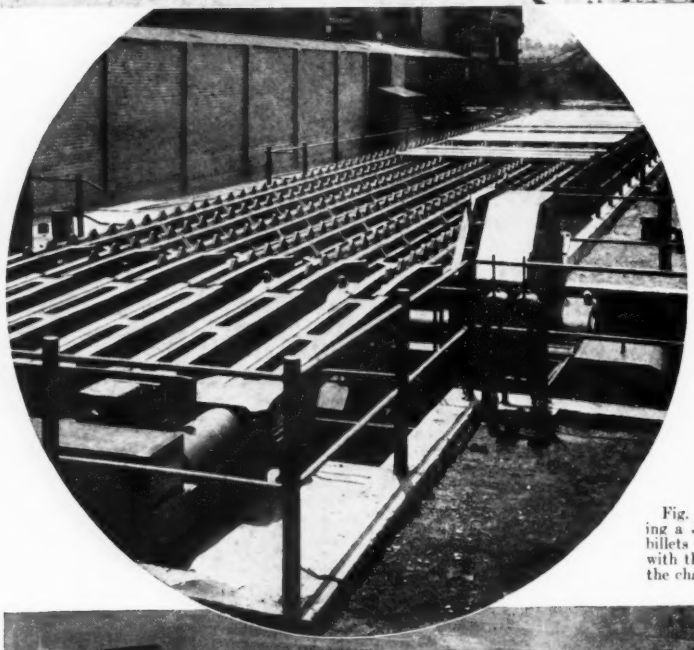


Courtesy of Robins Conveying Belt Co.

Fig. 6 (Left)—A Robins Mead-Morrison unloading tower. Such conditions of operation impose a severe duty upon lubrication.

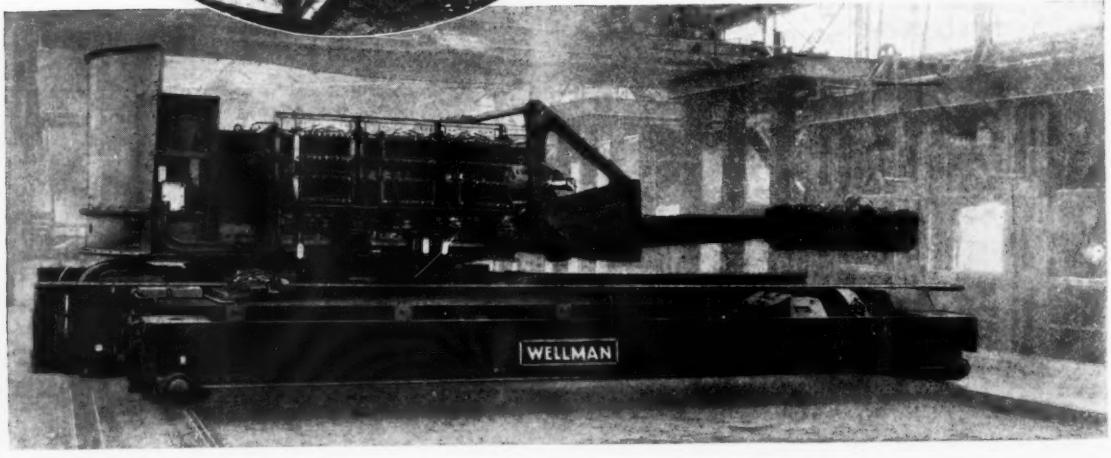
Courtesy of Industrial Brownhoist Corp.

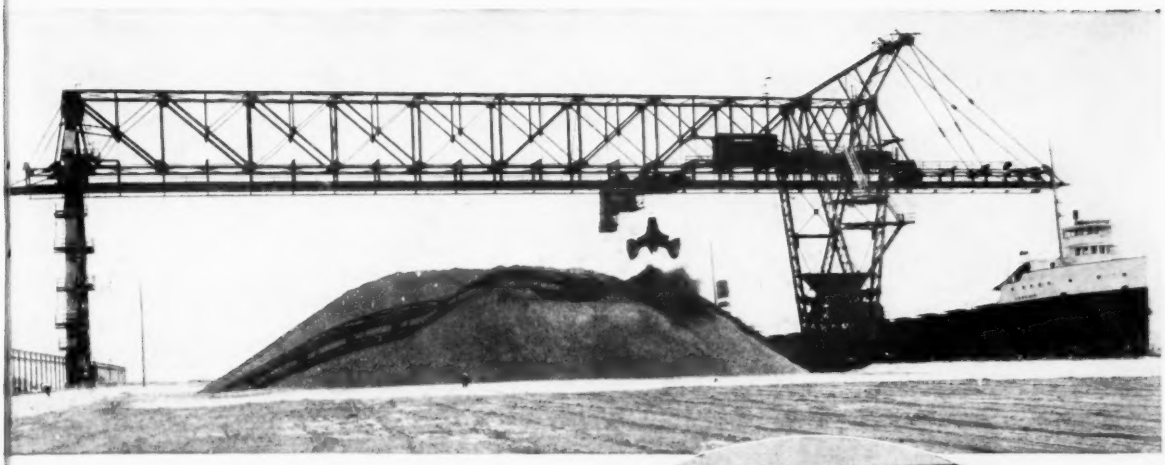
Fig. 7 (Right)—An excellent view of the span which can be covered in coal and ore bridge design.



Courtesy of The Jeffrey Mfg. Co.

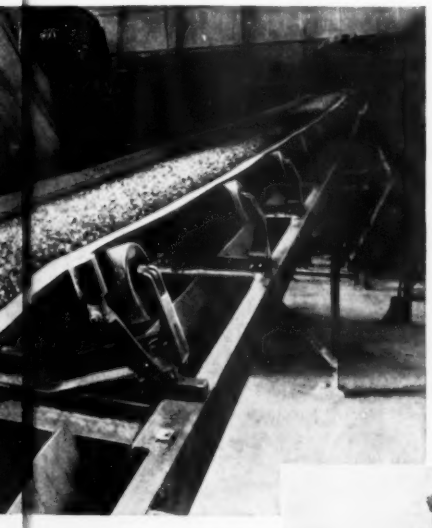
Fig. 8 (Left)—A contrast in operating temperature—showing a Jeffrey billet cooling and straightening bed. Here the billets enter the bed at 1900 degrees Fahr., in direct contact with the chain; hence the need for most careful lubrication of the chain links.





Courtesy of Link-Belt Company

Fig. 10 (Right)—Showing a rotary car dumper—another factor in handling of bulk materials.

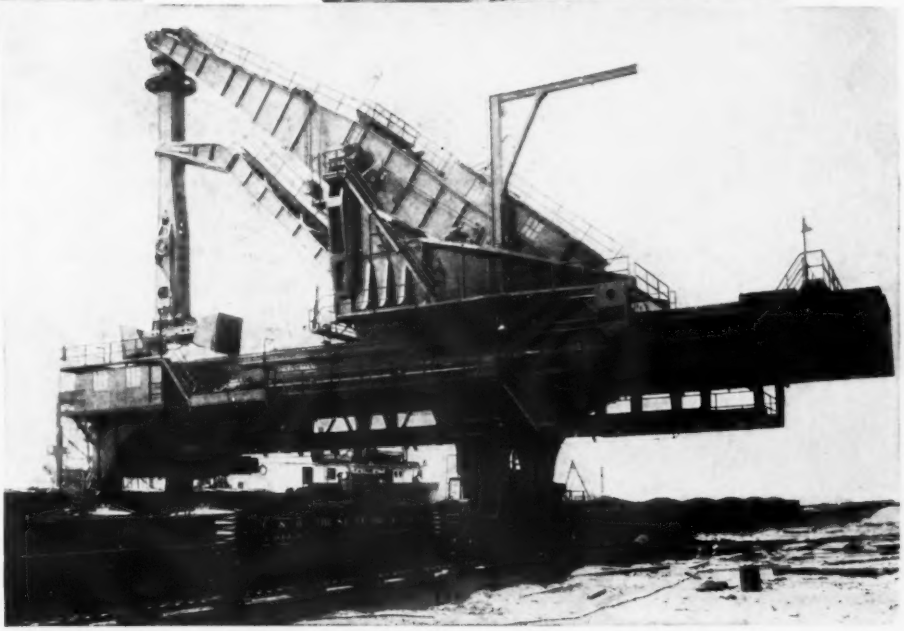


Courtesy of Link Belt Company

Fig. 9 (Above)—The conveyor often functions in conjunction with the ore bridge and unloader. It is especially valuable for long-distance handling of materials.

Courtesy of The Wellman Engineering Co.

Fig. 11 (Left) A Wellman revolving-door type slag furnace charging machine—another instance of "high temperature" lubrication.

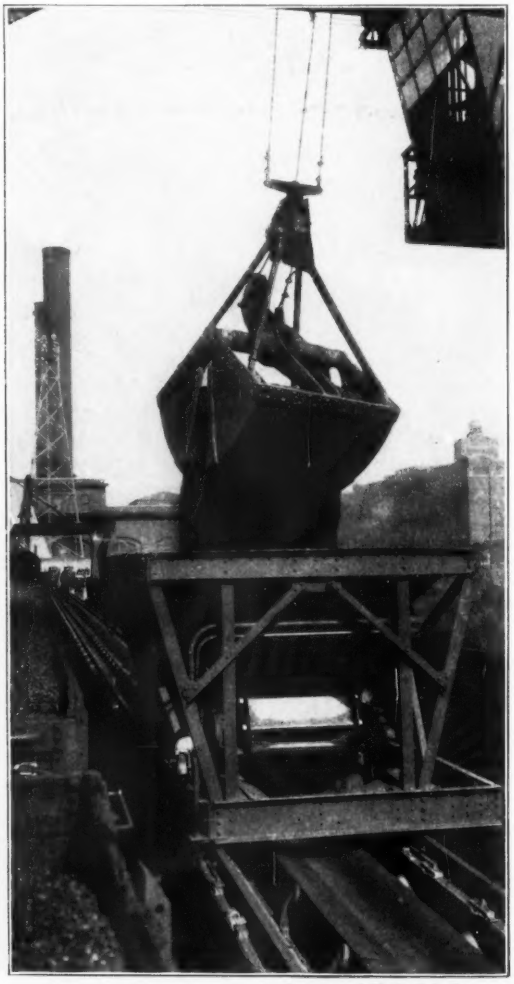


Courtesy of The Wellman Engineering Co.

Fig. 12 (Right)—The automatic ore unloader is distinctive for its massive design and the means provided for protected lubrication.

the development of centralized lubricating equipment, which once installed and properly adjusted will assist greatly in overcoming the detriments of dripped lubricants from overhead equipment. This class of lubricating equipment also greatly reduces the personal hazard.

The research studies of the petroleum industry have been equally intensive and considerable time and effort have been spent in the development of suitable greases to meet high temperature conditions and capable of application through centralized lubrication systems.



Courtesy of Chain Belt Company

Fig. 13—A Rex-Stearns belt conveyor equipped with Timken idlers. Bearing design to prevent grease contamination is most important in such an installation.

BELT CONVEYING

Conveying of bulk materials was referred to in the technical literature of the early Nineteenth Century, with mention of the bucket, belt or screw types in flour and grist mill service. Whether or not such installations were practicable is questionable; at least, however, there is evidence of working operations in foundry and metal working plants shortly thereafter. It is safe to say, therefore, that the iron and steel industry sponsored the belt conveyor, at least, for the handling of raw materials in bulk, to expedite their process-work; in reality this was one of the early stages of mass production.

Conveyor design has progressed markedly since those early days. Industry has appreciated the advantages to be derived from handling bulk materials mechanically. Primarily a labor saving device in the beginning, the belt conveyor soon proved its adaptability to speeding up production and reducing personal hazards to plant personnel. It was logical, then, for this type of conveyor to become one of the most widely applied mechanisms in the entire field of industrial production. Until today, it is used outdoors or indoors; for coal, ore, grain, sugar beets, crushed stone, packaged foodstuffs or beer bottles, etc.; for one-level transportation or for elevating purposes.

The belt conveyor involves an endless belt of rubberized fabric, canvas or cotton, designed to travel over pulleys at the conveyor ends, the loaded area being supported on troughed idlers. For the handling of bulk materials, the idler assemblies are so designed as to allow the belt to form a natural trough. Packaged materials, on the other hand, can readily be handled on a straight flat belt. The return or lower part of the belt is normally carried over straight idlers, regardless of the angle of the working side of the belt.

Conveyors of this type will handle any materials which will not adhere to its carrying surface and which can be fed thereto, at an angle up to 18 or 20 degrees, according to the nature of the product to be handled. Most economical handling, of course can be accomplished where the belt can be run at the maximum speed for the products handled. For large loose materials this will range from 100 to 300 feet per minute for a fourteen-inch belt, with the possibility of increase up to 700 feet for wider belts carrying finer products such as grain. Package conveyors, in turn, function best within a speed range of from 75 to 125 feet per minute. Picking and sorting conveyors, however, must be slowed down to around 50 feet or less, for here one must consider the speed at which the operators can work.

Belt Materials

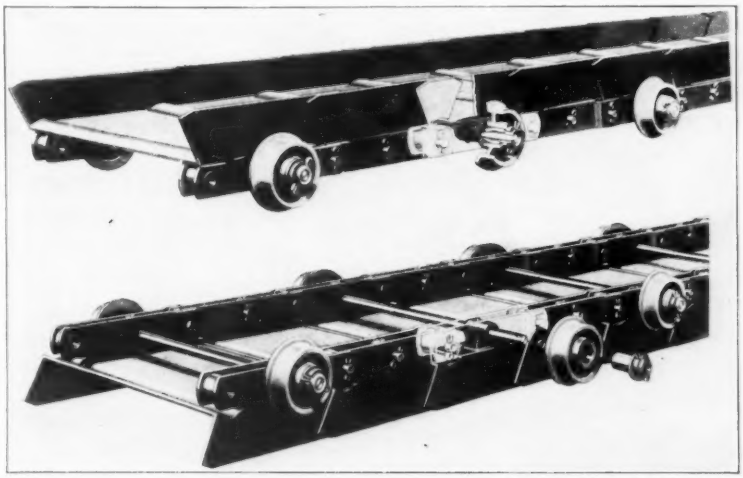
Conveyor belting must be chosen with due regard for the type of materials to be handled, their prevailing temperatures, their moisture

content and plasticity. Belts of rubber construction are suited to handling any type of wet or dry materials which are relatively non-plastic. The maximum temperature under which such belts should be used is in the neighborhood of 200 degrees Fahr. Continued contact with materials any hotter will cause premature deterioration of the fabric.

For temperatures above this range, but not exceeding approximately the boiling point of water, a type of stitched canvas belt has been developed which is capable of handling either wet or dry materials, provided they are not too plastic or abrasive.

Cotton belting in turn is adaptable to handling of light, dry, non-abrasive materials or packaged goods at normal temperatures. The cotton belt possesses a distinct advantage in that it combines strength with exceptional flexibility.

Normally, where any type of belt material may have to come in contact with oils, acids, water, steam or corrosive gases, it should be specially treated to render the structure impervious to their destructive action.



Courtesy of Chain Belt Company

Fig. 14—A Rex outboard roller apron conveyor; note the cut-away roller to show its design.

Power Consumption

The amount of power required for operation is an important item in belt conveyor operation. This will, of course, be governed by the length, the load, the incline and the tension on the belt. Experience has proved that by handling the belt over free rolling troughed idlers the power consumption can be materially reduced. Hence the advantage of the anti-friction bearing and positive lubrication with a low torque grease capable of functioning over a wide range of temperatures. On the other hand, the sleeve type bronze-bushed bearing may be applicable to certain types of work, especially where belts of considerable width are used requiring an idler assembly of cast iron pulleys.

The experienced operator, however, considers more than the rolling of the idlers. He must also be concerned with the running straightness of the sides of the belt. The self-aligning idler is advantageous in this regard as it automatically trains the belt, thereby eliminating the need for side guide idlers; spillage is also reduced. Idlers of this type are said to be particularly desirable where the belt is subject to widely varying load and where the latter cannot be distributed evenly with respect to the center of the belt. Any unevenness is regarded as an indication of wear and scuffing of the side of the belt as it runs over certain idlers, due to improper adjustment of the latter. Good judgment is, of course, necessary to determine this. To the casual observer inspection of such a conveyor might seem to indicate that all parts are operating quite satisfactorily, yet there might be serious power losses.

In conveyor service one must consider, therefore, belt wear along with bearing wear. Both are at times difficult to prevent in a conveyor having a thousand or more sets of rolls and a belt several thousand feet in length. Both, furthermore, will lead to marked increase in power consumption. Belt wear, as induced by scuffing, in turn, is claimed to increase the running temperature of the belt fabrics, which will ultimately reduce the carrying strength and cause breakage.

So, belt conveyor troughing and return rolls must be studied from two angles:

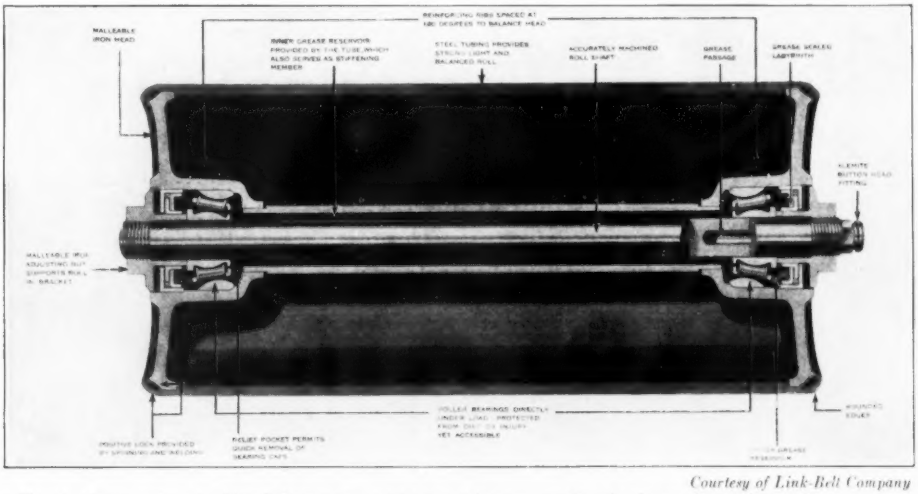
1. That of adjustment in order that the alignment of each conforms as nearly as possible to the operating line of the belt, and
2. That of lubrication and prevention of contamination of lubricants.

Use of the Anti-friction Bearing

The conveyor designer has gone largely to the ball or roller bearing. In addition, he has studied pressure lubrication, bearing seals and methods of grease application. The result has been the development of a highly satisfactory design in practically all respects.

The operator, in turn, is interested in ease of lubrication, for with many thousand roll sets,

it is obvious that re-lubrication may be slighted if it involves much trouble. It is for this reason that some sets are designed for lubrication from one or two points only—at the end of one or both of the side rolls, with provision for distribution of grease through suitable ducts to the bearings of the center rolls.

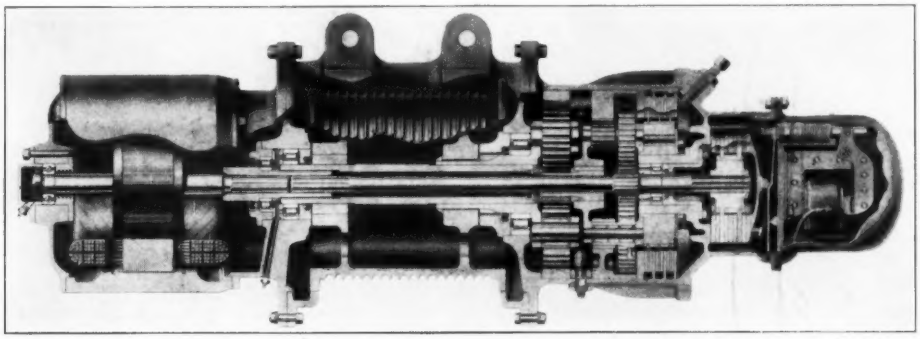

MALLEABLE IRON HEAD
INNER GREASE RESERVOIR PROVIDED BY THE TUBE WHICH ALSO SERVES AS STIFFENING MEMBER
STEEL TUBING PROVIDES STRONG, LIGHT AND BALANCED ROLL
ACCURATELY MACHINED ROLL SHAFT
GREASE PASSAGE
GREASE SEALED LABYRINTH
ROLLER BEARINGS DIRECTLY UNDER LOAD, PROTECTED FROM DIRT BY GREASE YET ACCESSIBLE
RELIEF POCKET PERMITS QUICK REMOVAL OF BEARING CUPS

Courtesy of Link-Belt Company

Fig. 15—Cross-section of a Link Belt type 70, anti-friction belt conveyor idler showing method of lubrication.

By charging the bearing lubricating system at regular intervals, pressure can be built up from within to effectively prevent entry of abrasive or corrosive foreign matter. An added feature is the application of a highly protective type of labyrinth seal which not only aids to prevent entry of dust and dirt, but also serves to work the lubricant to maintain its texture and prevent separation, hardening and premature breakdown.

The use of a cone-shaped seal capable of expanding when acted upon by the charge of grease under pressure from the grease gun has also been used to good advantage. In the opinion of some authorities, however, lubricating in this manner may lead to insufficient lubrication of the center roll if the lubricating system can become air bound. Under such conditions, the trapping of air in pockets in the bearing housings might prevent complete circulation of grease. For this reason they prefer to lubricate the bearings of each roll individually by partial disassembly of the roll set at the time of lubrication. The apparent success resulting from this procedure is indicated by the reported necessity for relubrication but once every three months, and the contention of operators that their power and repair costs are consistently low.



Courtesy of Shepard Nils Crane & Hoist Corp.

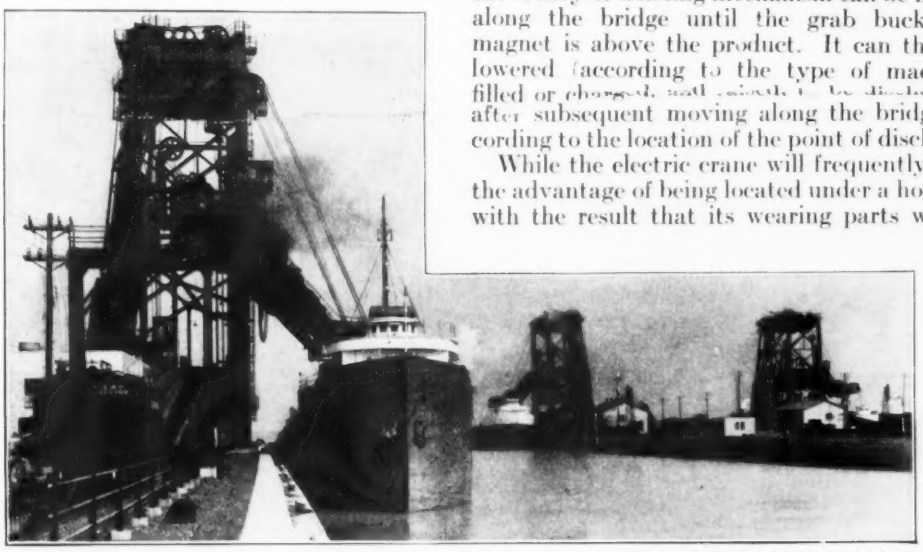
Fig. 16—Details of the Shepard Niles "Liftabout" hoist. The fully enclosed nature of this mechanism is a decided adjunct to lubrication. Grease is used to serve the roller bearings, the gears operating in a bath of oil.

THE UNLOADER AND ORE BRIDGE

The steel industry again came into prominence as a sponsor of materials handling equipment when it turned to the unloader and ore bridge for handling iron ore from the lake steamers. So the ore bridge, unloading bridge

and automatic unloader came to be developed. Such devices are flexible, automatic and readily maneuvered with a minimum of labor.

An ore bridge, or unloading bridge is very similar to an electric crane, consisting of a frame which is mounted on suitable end trucks or carriages; a runway or track on which these latter travel; an overhead trolley capable of traveling along the bridge, and a grab bucket or electro-magnet arrangement which operates from the trolley.



Courtesy of Industrial Brownhoist Corp.

Fig. 17—An electrically operated car-dumper showing the practicability of handling large volumes of materials. The exposed nature of the mechanism requires very careful lubrication.

In the unloading bridge that part from which the hoisting device operates is often either hinged to form a jib, or arranged so as to telescope within the main structure of the bridge. The object of such construction is to enable operation of the hoisting mechanism between the masts of ships or other obstacles.

The automatic unloader is another interesting device which is also widely used for the unloading of ore and coal from the holds of vessels. This device, in turn, comprises a main framework which is mounted on trucks in a similar manner to a crane bridge. These trucks run along track work or runways on the wharf, thus enabling movement of the entire frame. On the bridge or framework is mounted a trolley which carries a balanced walking beam. From the outer or hoisting end of this latter is suspended a rigid hoisting leg with a grab bucket at the bottom. Within this leg are located the bucket operating gears, chains and other mechanism pertinent to horizontal motion. Vertical movement is brought about by operation of the walking beam.

Flexibility

The ore bridge and unloader permits of three-way motion; as a result, the materials handling elements can be readily and accurately located with respect to the hatch of a vessel, a car or the storage yard; and its hoisting media made to function with a maximum of delivery. In other words, after locating the bridge proper, the trolley or hoisting mechanism can be moved along the bridge until the grab bucket or magnet is above the product. It can then be lowered (according to the type of machine) filled or charged, and raised to be discharged after subsequent moving along the bridge according to the location of the point of discharge.

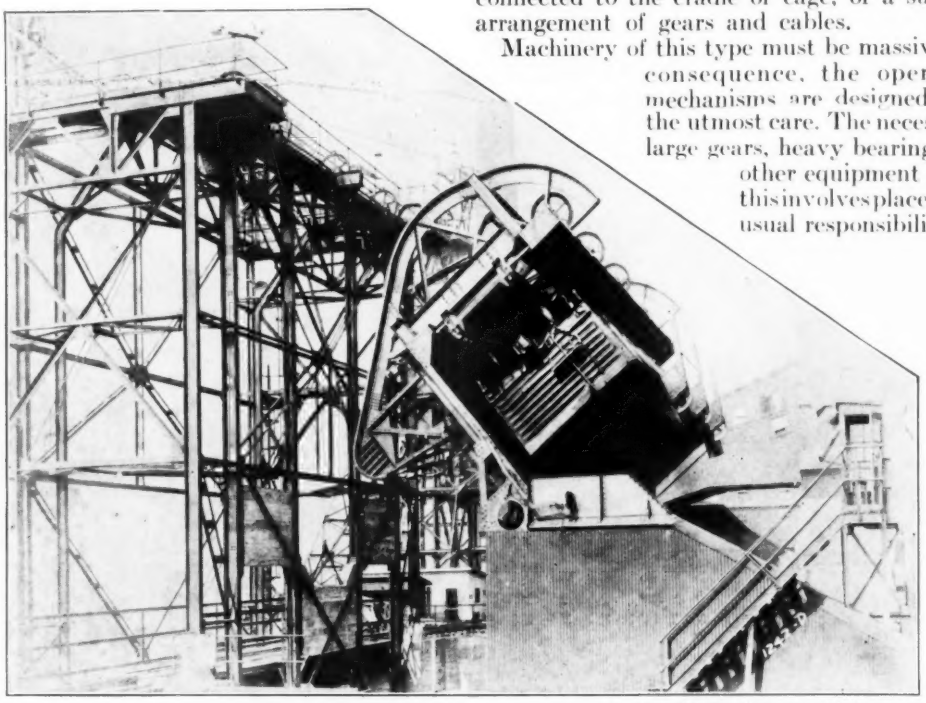
While the electric crane will frequently have the advantage of being located under a housing, with the result that its wearing parts will be more or less protected from the elements, the ore bridge and unloader will, as a rule, be located in the open, along with the car dumper, and other types of such equipment which are used for handling materials in bulk. As a result, its operating elements will require the same careful attention from a lubricating point of view.

Importance of Lubrication

Ore bridge and unloader lubrication is essentially a matter of counteracting the effects of detrimental weather conditions by the use of oils, greases and gear and wire rope compounds which are especially capable of protecting the wearing elements.

These lubricants should be selected with the utmost care; the management must appreciate that in most cases they will be called upon to function in the open, subjected to widely varying temperature conditions, and sometimes in the presence of rain, snow and ice. Furthermore, many of the wearing elements to be lubricated will be located in more or less inaccessible or hazardous parts, where labor will have a tendency to neglect in the interests of personal safety.

In consequence, gear, wire rope and bearing lubrication on such equipment will differ markedly from that involved under more favorably housed conditions in many other industries. Then again, there will always be a certain amount of abrasive foreign matter or dust in the air which will have a tendency to become mixed with the lubricants to ultimately cause scoring and abnormal wear.



Courtesy of Robins Conveying Belt Company

Fig. 18—A Robins Mead-Morrison coal car dumper showing the massive nature of the construction essential in this type of materials handling.

On much of such materials handling equipment but few provisions for bath or enclosed lubrication are possible. As a result the lubricants must give maximum protection.

THE CAR DUMPER

In the handling of coal, ore and other products from cars to storage yards or bins the motor-driven car dumper or unloader is a valuable piece of equipment due to the ease, rapidity and economy with which it accomplishes an otherwise dirty job.

In principle the car dumper, as its name implies, involves a huge tilting, rotating or lifting mechanism which actually tips a car to empty the contents via a chute into the storage yard, bin, hold of a boat or, perhaps, another car. In general, it is quicker and involves less labor than emptying cars at railway terminals, in the loading or coaling of ships, and the delivery of ore to blast furnace storage and mixing bins. The same principle has also been extended to the unloading of closed cars such as are used for transporting grain and sugar cane.

Electric power is used to operate a car dumper, two motors being necessary, one for operating the clamping mechanism, the other for tilting or rotating the cradle or cage. The actual media for operating the latter, however, may be hydraulic pressure actuating a plunger connected to the cradle or cage, or a suitable arrangement of gears and cables.

Machinery of this type must be massive. In consequence, the operating mechanisms are designed with the utmost care. The necessarily large gears, heavy bearings and other equipment which this involves place an unusual responsibility upon the operator after such a machine is installed, due to the exacting lubricating requirements.

In brief, lubrication is the primary means by which such equipment can be kept ready for continuous and efficient operation. The loads involved in handling a 70 or 90 ton gondola car are enormous and impose a duty on bearings and gear teeth, which in other industries would be considered prohibitive. To meet these conditions the lubricants employed must be so refined as to maintain a lubricating film capable of resisting any squeezing out action; also they must possess adequate fluidity and low pour test to function under low temperature conditions. Car dumpers are exposed to the elements, located very frequently on the coast or great lakes where cold, wind, rain, hail, snow and ice must be met and counteracted. Hence the caution regarding pumpability where selecting lubricating oils, greases and gear compounds.

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